Physiculus sudanensis Paulin, 1989, a junior synonym of *P. dalwigki* Kaup, 1858 (Teleostei, Gadiformes, Moridae), with a redescription of *P. dalwigki*

by

Manuel BISCOITO* (1) & José A. GONZÁLEZ (2)

Abstract. – Validity of *Physiculus sudanensis* was questioned based on the similarities with *Physiculus dalwigki* and the erroneously assigned type location of 'Côtes du Soudan' in the Indian Ocean. After a careful comparison with the holotype of *P. dalwigki*, *P. sudanensis* is herein considered as a junior synonym of *P. dalwigki*. A redescription of *P. dalwigki* is also presented. The genus *Physiculus* now contains 41 species worldwide, 10 of which occur in the Indian Ocean.

Résumé. – *Physiculus sudanensis* Paulin, 1989, synonyme junior de *P. dalwigki* Kaup, 1858 (Teleostei, Gadiformes, Moridae), et redescription de cette dernière espèce.

La validité de l'espèce *Physiculus sudanensis* a été remise en question par les auteurs, qui ont trouvé beaucoup de similarités avec *P. dalwigki* et une erreur de localisation de la localité typique de l'océan Indien. Après une comparaison avec l'holotype de *P. dalwigki*, les auteurs considèrent que *P. sudanensis* est un synonyme junior de *P. dalwigki*. À présent, le genre *Physiculus* est représenté par 41 espèces au niveau mondial, dont 10 sont présentes dans l'océan Indien.

© SFI

Received: 3 Apr. 2017
Accepted: 16 Feb. 2018
Editor: G. Duhamel

Key words
Moridae
Physiculus sudanensis
Physiculus dalwigki
Atlantic Ocean
Indian Ocean
Species validity

The genus *Physiculus* Kaup, 1858 currently contains 42 valid species distributed worldwide, 9 of which occurring in the Atlantic and 11 in the Indian Ocean (Eschmeyer *et al*., 2017; Froese and Pauly, 2017). Seven species occur in the eastern Atlantic Ocean: *P. cyanostrophus* Anderson & Tweddle, 2002, *P. dalwigki* Kaup, 1858, *P. helenaensis* Paulin, 1989, *P. huloti* Poll, 1953, *P. karrerae* Paulin, 1989, *P. maslowskii* Trunov, 1991, and *P. microbarbata* Paulin & Matallanas, 1990 (Froese and Pauly, 2017). The Indian Ocean species are: *P. andriashevi* Shcherbachev, 1993, *P. argyropastus* Alcock, 1894, *P. beckeri* Shcherbachev, 1993, *P. bertelseni* Shcherbachev, 1993, *P. capensis* Gilchrist, 1922, *P. fedorovi* Shcherbachev, 1993, *P. marisrubri* Brüss, 1986, *P. natalensis* Gilchrist, 1922, *P. nielseni* Shcherbachev, 1993, *P. normani* Brüss, 1986, and *P. sudanensis* Paulin, 1989 (Froese and Pauly, 2017).

Further examination to the origin of the type material of *P. sudanensis* led to the discovery that the specimens were collected by Vaillant (1888: 290-292) during the 'Talisman' cruise in 1883 (Fig. 1) and were deposited in the Muséum national d'Histoire naturelle (MNHN, Paris). Vaillant (*op. cit*.) mentioned the collection of 6 specimens he identified as *P. dalwigki*. These were collected at two different stations ('dragages'), LXII, 782 m and LXXI, 640 m, both localized at 'Côtes du Soudan'. Looking at the MNHN fish database, available through FishBase (Froese and Pauly, 2017), it was possible to obtain the detailed collection data and pinpoint the locations to the SW of Cape Bojador, off the Western Sahara, NW Africa (Fig. 1).

Paulin (1989b), when revising the morid genus *Physiculus*, looked at Vaillant specimens and considered them as a new species, naming it as *P. sudanensis*. Moreover, he gathered three more paratypes, one from the Socotra-Chagos Ridge and two others from the West Indian Ridge (Indian Ocean), and gave the Red Sea off the coast of Sudan and the nearby Indian Ocean as the species distribution area.

Obviously, the specific epithet came from the collection locality given by Vaillant (1888), 'Côtes du Soudan'. As already pointed by Bailly *et al*. (1999), unfortunately Paulin did not realize that in Vaillant times, the Soudan region was a vast area in central precolonial Africa, between the Sahara and the tropical region, extending from the Atlantic Ocean to the Red Sea (Van Chi-Bonnardel, 1973), an area

---

(1) Funchal Marine Biology Station, MARE Sea and Environment Sciences Centre & OOM – Madeira Oceanic Observatory, Funchal Natural History Museum, Rua da Mouraria 31, 9004-546 Funchal, Madeira, Portugal.

(2) Applied Marine Ecology and Fisheries Group, i-UNAT, University of Las Palmas de Gran Canaria, Campus Universitario de Tafira, 35017 Las Palmas de Gran Canaria, Spain. [pepe.solea@ulpgc.es]

* Corresponding author [manuel.biscoito@cm-funchal.pt]

Cybium 2018, 42(2): 189-194.

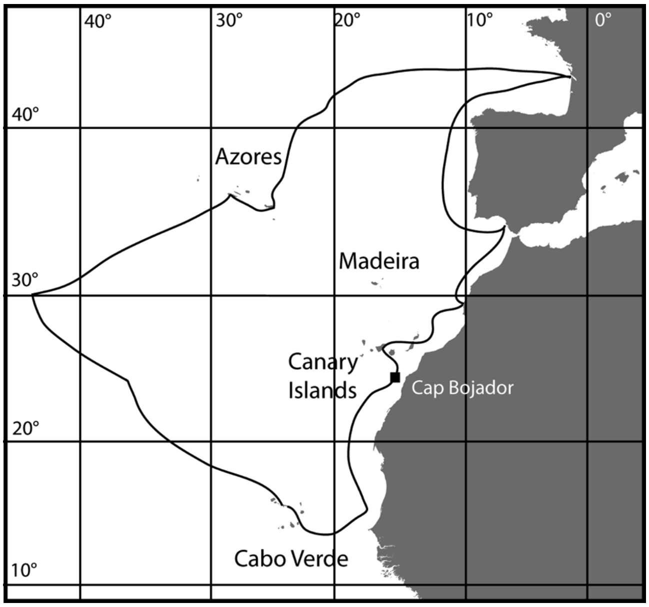

Figure 1. – Cruise map of the *Talisman* expedition in 1883 (after Filhol, 1885), with collection locations of *Physiculus sudanensis* (solid square).

now referred as the Sahel or sub-Saharan Africa. And in fact, 'Côtes du Soudan' in Vaillant times was an area from mid-Western Sahara (Cape Bojador) to Senegambia. Moreover, Paulin (1989b) also did not notice that Vaillant expedition never went to the Indian Ocean, and therefore, whatever Vaillant specimens were, they undoubtedly represent an Atlantic species and not one from the Indian Ocean.

Shcherbachev (1993), when revising the *Physiculus* species from the Indian Ocean and adjacent waters of the South Atlantic, found that three paratypes of *P. sudanensis* belong in fact to new species, *P. fedorovi* (holotype) and *P. bertelseni* (two paratypes), the three Indian Ocean specimens Paulin added to the type series of *P. sudanensis*. Nevertheless, Shcherbachev (1993) has maintained *P. sudanensis* as a valid species restricted to the Red Sea, off the coast of Sudan.

Bearing in mind the high similarity found between *P. sudanensis* and *P. dalwigki*, already noticed by Paulin (1989b), a detailed comparison between the known specimens of *P. sudanensis* and *P. dalwigki* was done, the results of which are presented herein.

Paulin (1989b), while dealing with *P. dalwigki*, mentioned the fact that Kaup (1858) described this species based on specimens (*sic*) from the Muséum national d'Histoire Naturelle, Paris and at that time (late 1980s) the holotype was considered as lost. He therefore designated a specimen from Madeira deposited in the Natural History Museum, London (BMNH 1855.11.29.26) as a neotype of *P. dalwigki*.

The rediscovery of the holotype of *P. dalwigki* in Paris (Bailly *et al.*, 1999) allowed a full comparison with other material and the published descriptions, both by Kaup (1858), Günther (1862) and Paulin (1989b). As some discrepancies have been found between Paulin description and the observed type material, Kaup's original description is very succinct and Günther's, although detailed, is not based on the holotype, a redescription of the species is given herein.

MATERIAL AND METHODS

Standard and ichthyological meristic and morphometric measurements were made following Hubbs and Lagler (1958). Other counts and terminology follow Paulin (1989b). Light organ measurements follow Shcherbachev (1993). Fin-ray and vertebral counts were obtained from radiographs.

Institutional acronyms follow Sabaj Pérez (2010). Other abbreviations as follows: SL – standard length; TL – total length; HL – head length; D – dorsal fin rays; A – anal fin rays; P – pectoral fin rays; V – pelvic fin rays; C – caudal fin rays; InV-af – distance between interventral line and origin of anal fin; InV-Lo – distance between interventral line and anterior margin of light organ; Lo-An – distance between posterior margin of light organ and anus; LoD – light organ diameter.

***Physiculus dalwigki* Kaup, 1858**

(Figs 2-7; Tab. I)

Physiculus dalwigki Kaup, 1858: 88 (possibly Mediterranean Sea). Paulin, 1989b: 109-110 (Madeira, designation of neotype).

Physiculus sudanensis Paulin, 1989b: 124-125 (Côtes du Soudan, 640 m, muddy sand, shells and corals, bottom trawl, St. 71; Côtes du Soudan, Cape Bojador (Sahara), 782 m, sand and shells, corals, bottom trawl, St. 62, Talisman cruise 1883, Vaillant coll.).

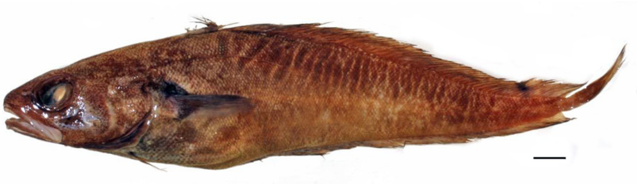

Figure 2. – *Physiculus dalwigki*, holotype, MNHN 1996-1380. Scale bar = 10 mm.

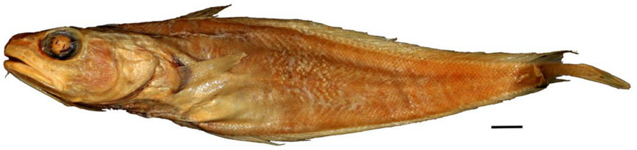

Figure 3. – *Physiculus dalwigki*, ex-neotype, BMNH 1855.11.29.26. Scale bar = 10 mm.

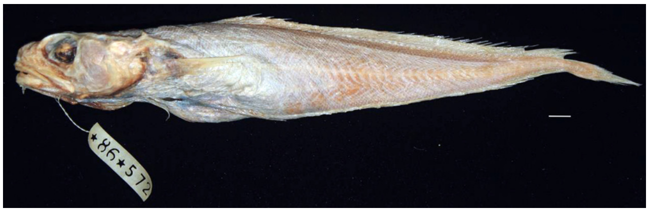

Figure 4. – *Physiculus sudanensis*, holotype, MNHN 1886-572. Scale bar = 10 mm.

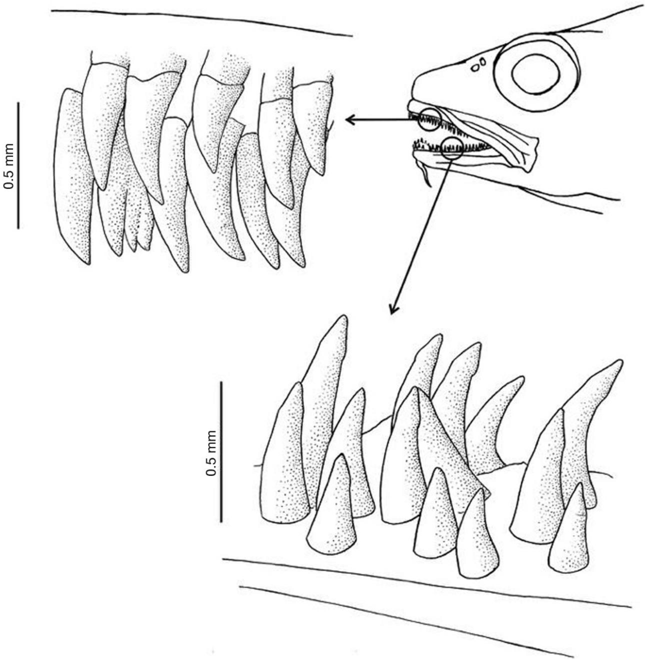

Figure 5. – Teeth of *Physiculus dalwigki* (MMF 39704, 232 mm SL). Same arrangement as in holotype.

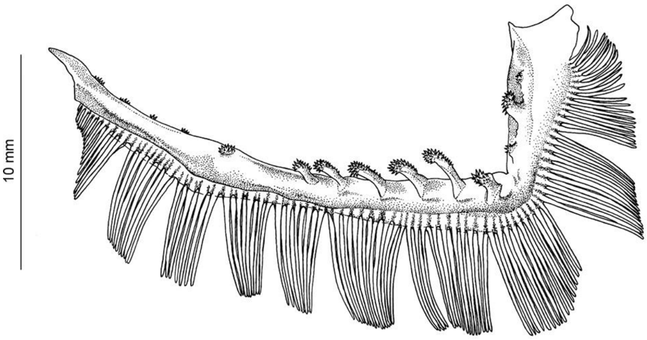

Figure 6. – Gill rakers on first gill arch of *Physiculus dalwigki* (MMF 39704, 232 mm SL). Same number and shape as in holotype.

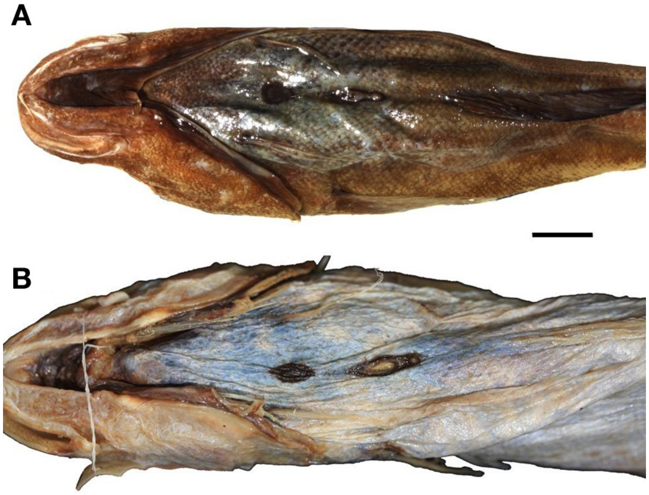

Figure 7. – Ventral light organ of *Physiculus dalwigki*. **A**: Holotype (MNHN 1996-1380); **B**: Holotype of *Physiculus sudanensis* (MNHN 1886-572). Scale bar = 10 mm.

Material

Holotype, MNHN 1996-1380, 190 mm SL, unknown collection data, probably Mediterranean (Kaup, 1858) (Fig. 2); BMNH 1855.11.29.26, 193 mm SL, Madeira, R. T. Lowe *leg* (ex-neotype) (Fig. 3); MNHN 1886-0572, 262 mm SL, Côtes du Soudan, 640 m, muddy sand, shells and corals, bottom trawl, St. 71, Talisman cruise 1883, Vaillant coll. (in MNHN database: Maroc, Sahara, Bojador (c.), 25°39’0”N, 15°58’1”W, corail, sable) (holotype of *P. sudanensis*) (Fig. 4); MNHN 1886-0570, 156 mm SL, MNHN 1886-0571, 115 mm SL, MNHN 1886-0573, 231 mm SL, same collection data as MNHN 1886-0572; MNHN 1886-0574, 225 mm SL, Côtes du Soudan, Cape Bojador (Sahara), 782 m, sand and shells, corals, bottom trawl, St. 62, Talisman cruise 1883, Vaillant coll. (in MNHN database: Maroc, Sahara, 26°19’59”N, 14°52’59”W) (paratypes of *P. sudanensis*); MMF 39704, 232 mm SL, eastern Atlantic Ocean, Cape Verde Islands, Boa Vista, off Ponta do Sol, 16°19’N, 23°03’W, 420-506 m depth, cruise ‘Cabo Verde 2005-06’, St. 5/7, bottom trap, 5 Jun. 2005, J.A. González *leg*.

RESULTS AND DISCUSSION

Diagnosis

A species of *Physiculus,* as defined by Paulin (1989a) and Shcherbachev (1993), with the following combination of characters: distance from interventral line to anterior margin of light organ nil or very short (0.0%-6.1% InV-af); scales in longitudinal series ca. 134; scale rows between base of first dorsal fin and lateral line 10-13; D1 7-8, D2 63-67; A 67-72; P 24-26; V 5-5; vertebrae: 56-59.

Description

Body elongate, laterally compressed in the posterior part; greatest body depth at level of the origin of anal fin, slightly more than five times into SL (14.3%-22.4%); head moderately conical (23.7%-25.8% SL); eye large (24.1%-29.0%

Table I. – Morphometric and meristic data from the type material of *Physiculus dalwigki* and *Physiculus sudanensis*.

	P. dalwigki (holotype) MNHN 1996-1380 190 mm SL		*P. dalwigki* (ex-neotype) BMNH 1855.11.29.26 193 mm SL		*P. sudanensis* (holotype) MNHN 1886-0572 262 mm SL		*P. sudanensis* (paratype) MNHN 1886-0573 231 mm SL		*P. sudanensis* (paratype) MNHN 1886-0574 225 mm SL	
Body proportions	in %SL	in %HL	in %SL	in %HL	in %SL	in %HL	in %SL	in %HL	in %SL	in %HL
Predorsal 1 length	29.2	–	29.0	–	28.2	–	26.8	–	27.1	–
Predorsal 2 length	37.5	–	35.8	–	34.0	–	33.3	–	32.4	–
First dorsal fin base length	6.3	–	6.2	–	6.1	–	5.6	–	5.8	–
Second dorsal fin base length	60.9	–	61.7	–	63.7	–	62.8	–	64.0	–
Preanal length	37.0	–	33.7	–	35.9	–	35.1	–	36.0	–
Anal fin base length	58.3	–	62.2	–	61.8	–	61.0	–	60.4	–
Pre-anus length	27.1	–	28.0	–	26.0	–	25.5	–	27.1	–
Pectoral fin length	14.6	–	13.0	–	13.0	–	12.1	–	12.4	–
Prepectoral length	26.0	–	28.0	–	26.7	–	26.8	–	27.6	–
Maximum body depth	22.4	–	19.2	–	17.9	–	14.3	–	17.8	–
Least depth of caudal peduncle	2.3	–	2.1	–	2.3	–	2.2	–	2.2	–
Caudal peduncle length	6.8	–	3.1	–	5.3	–	5.6	–	5.3	–
Head length	24.5	–	24.4	–	23.7	–	23.8	–	25.8	–
Preopercular length	18.8	76.6	19.2	78.7	19.1	80.6	19.5	81.8	19.6	75.9
Snout length	5.7	23.4	5.7	23.4	6.1	25.8	5.6	23.6	6.2	24.1
Eye diameter	6.8	27.7	6.7	27.7	6.9	29.0	6.1	25.5	6.2	24.1
Inter-orbital width	4.7	19.1	4.7	19.1	5.0	21.0	5.2	21.8	4.9	19.0
Upper jaw length	11.5	46.8	11.4	46.8	13.0	54.8	11.7	49.1	11.6	44.8
Gape length	7.8	31.9	9.8	40.4	10.7	45.2	9.1	38.2	9.3	36.2
Chin barbel length	3.0	12.3	1.8	7.4	2.3	9.7	2.2	9.1	2.2	8.6
Head height at posterior border of orbit	14.1	57.4	12.4	51.1	13.0	54.8	11.7	49.1	12.0	46.6
Morphometrics										
Pelvic fin reaching anal fin ray no.	Not reaching		Not reaching		Not reaching		Not reaching		Not reaching	
Pectoral fin reaching second dorsal fin ray no.	2		4		5		5		5	
Continuous tube of lateral line reaching…	4th-5th ray of 1st dorsal		?		Origin of 1st dorsal		3rd ray of 1st dorsal		2nd ray of 1st dorsal	
Discontinuous tubes of lateral line reaching…	Caudal peduncle		?		–		–		Mid-point of 2nd dorsal	
Meristics										
First dorsal fin rays	8		7		7		8		8	
Second dorsal fin rays	63		67		65		64		63	
Anal fin rays	67		72		70		68		70	
Pectoral fin rays	23		24/25		25		26		25	
Pelvic fins rays	4		5		5		5		5	
Branchiostegal rays	6		7		7		7		7	
Gill rakers (1st arch)	3+7		3+8		3+7		3+8		3+6	
Scale rows between base of first dorsal fin and lateral line	13		10		13		12		12	
Scales in longitudinal series	134		–		–		–		–	
Vertebrae	16+43		16+42		14+42		15+42		15+43	
Light organ size and position	in% InV-af		in% InV-af		in% InV-af		in% InV-af		in% InV-af	
Light organ diameter (LoD)	18.2		24.1		19.0		20.0		17.6	

Table I. Continued.

	P. dalwigki (holotype) MNHN 1996-1380 190 mm SL	*P. dalwigki* (ex-neotype) BMNH 1855.11.29.26 193 mm SL	*P. sudanensis* (holotype) MNHN 1886-0572 262 mm SL	*P. sudanensis* (paratype) MNHN 1886-0573 231 mm SL	*P. sudanensis* (paratype) MNHN 1886-0574 225 mm SL
Distance between interventral line and anterior margin of light organ (InV-Lo)	6.1	0.0	0.0	0.0	2.9
Distance between posterior margin of light organ and anus (Lo-An)	19.7	20.7	19.0	17.1	20.6

HL); snout moderately long (23.4%-25.8% HL), blunt at tip; mouth terminal, slightly oblique, upper jaw reaching to vertical from centre of eye (Figs 2-4); jaw teeth small, slightly recurved, in a graded series, smaller in outer rows; symphyseal separation wide (Fig. 5); chin barbel small (7.4%-12.3% HL); outer gill rakers on first gill arch small, varying from spinous tubercles to small clubs with spinous tips near angle (Fig. 6).

Scales small, ca. 126-134 in longitudinal series; 10-13 scale rows between base of first dorsal fin and lateral line; scales present on head and gular region; 3 scale rows penetrating onto first dorsal fin; 1 scale row penetrating onto second dorsal and anal fins; lateral line starting above angle of opercle; continuous tube of lateral line very short, just reaching origin of first dorsal fin; discontinuous tubes of lateral line reaching caudal peduncle.

First dorsal fin higher than second, 3rd ray longest, a noticeable gap separating first from second dorsal fins; second dorsal fin origin slightly behind a vertical through origin of anal fin, both fins equally sized and not indented, their rear tips rounded; pectoral fins symmetrical, their origin almost at level of vertical through origin of first dorsal fin and extending to below 2nd to 5th second-dorsal fin rays; pelvic fins small, the first two rays elongate, not reaching anal fin; caudal peduncle narrow, caudal fin rounded and well separated from second dorsal and anal fins.

Light organ large (Fig. 7), its diameter (LoD) ranging from 17.6% to 24.1% InV-af and located immediately behind or very close to interventral line; distance from interventral line to anterior margin of light organ (InV-Lo) 0.0% to 6.1% InV-af; distance from posterior margin of light organ to anus (Lo-An) 17.1% to 20.7% InV-af.

Vertebrae: 14–16+42–43 = 56–59.

Other morphometric and meristic characteristics are given in table I.

Colouration in preserved specimens

Body overall brownish, abdomen and flanks lighter with bluish tinge; branchiostegal membranes black; peritoneum black.

Distribution

P. dalwigki is restricted to the eastern Atlantic Ocean and western Mediterranean Sea, from the Galicia Bank (42°44'N, 11°39'W) and along the African slope from the Strait of Gibraltar to at least 20°45'N (Mauritania), the Macaronesian archipelagos of the Azores, Madeira, Canaries, and Cape Verde and the mid-Atlantic seamounts south of the Azores (Shcherbachev *et al*., 1985; González *et al*., 1988, 2008, 2010; Paulin, 1989b; Cohen *et al*., 1990; Santos *et al*., 1997; Bañón *et al*., 2002; Menezes *et al*., 2004; Reiner, 2005). It has been caught between 100 m and 900 m of depth (Cohen *et al*., 1990; Shcherbachev *et al*., 1985).

Remarks

P. dalwigki can be distinguished from all other Atlantic *Physiculus* species by the position of its light organ (0-6.1% vs. 8.2-39.7% InV-af). Also its diameter is larger (17.6-24.1% vs. 5.2-13.2% InV-af) than in all other Atlantic species, but *P. karrerae* (14.8-21.3% InV-af), from which it differs by the position of the light organ (0.0%-6.1% InV-af vs. 8.2%-16.8% InV-af), arrangement of jaw teeth (graded vs. subequal), scales on gular region and vertical fin membranes (present vs. absent), continuous tube of lateral line just reaching origin of first dorsal fin (reaching beyond second dorsal fin origin in *P. karrerae*), and pelvic fins not reaching anal fin (reaching beyond the 1st anal fin ray in *P. karrerae*).

The existence of a well-preserved holotype of *P. dalwigki* (MNHN 1996-1380) (Fig. 2) makes the neotype designated by Paulin (1989b) (BMNH 1855.11.29.26) (Fig. 3) no longer valid and therefore with no type status.

Validity of *P. sudanensis* Paulin, 1989

After a comparison of the type material of *P. sudanensis* with the holotype and other material of *P. dalwigki* (Tab. I), no significant differences between the two species could be observed. Most of the body proportions and meristic characters overlap or differences found are minimal. Moreover, Paulin (1989b) diagnosis of *P. sudanensis* cannot be of any use, as it is the result of a mixture of three different species: *P. fedorovi*, *P. bertelseni* (Shcherbachev, 1993) and *P. sudanensis*.

The type locality of *P. sudanensis* is well within the area of distribution of *P. dalwigki*, the eastern Atlantic Ocean and not the coast of Sudan in the Red Sea, as Paulin (1989b) erroneously gave. The genus *Physiculus* contains many species and is widespread in all major oceans, but individual species have fairly restricted geographical distributions (Paulin, 1989a) and up to the present there are no known species occurring in more than one ocean basin (Froese and Pauly, 2017).

Therefore we come to the conclusion that *P. sudanensis* (Fig. 4) is a junior synonym of *P. dalwigki*.

Acknowledgements. – The authors are indebted to Romain Causse and Zora Gabsi (MNHN, Paris) and James Maclaine (NHM, London) for allowing the examination of the type material of *P. sudanensis* and *P. dalwigki*, including taking radiographs. Thanks are also due to Guy Duhamel for his editorial work and to anonymous referees, which improved the original manuscript. Financial support (JAG) was received from the Government of the Canary Islands and the EU ERDF in the framework of the PCT MAC 2007-2013 project MARPROF-CV (MAC//3/C124) and (MB) from the Madeira Oceanic Observatory (Project M1420-01-0145-FEDER-000001 – Observatório Oceânico da Madeira-*OOM*) and Fundação para a Ciência e Tecnologia (FCT), through the strategic project UID/MAR/04292/2013 granted to MARE. This is contribution no. 39 of the Marine Biology Station of Funchal.

REFERENCES

BAILLY N., HUREAU J.C. & PRUVOST P., 1999. – Catalogue critique des types de poissons du Muséum national d'Histoire naturelle (et des Musées d'histoire naturelle en région). *Cybium*, 23(3): 219-320.

BAÑÓN R., DEL RÍO J.L., PIÑEIRO C. & M. CASAS, 2002. – Occurrence of tropical affinity fish in Galician waters, northwest Spain. *J. Mar. Biol. Ass. UK*, 82: 877-880.

COHEN D.M., INADA T., IWAMOTO T. & SCIALABBA N., 1990. – FAO Species Catalogue. Vol. 10. Gadiform Fishes of the World (Order Gadiformes). An Annotated and Illustrated Catalogue Of Cods, Hakes, Grenadiers and other Gadiform Fishes known to date. *FAO Fish. Synop.*, 125(10): 442 p.

ESCHMEYER W.N., FRICKE R. & VAN DER LAAN R. (eds), 2017. – Catalog of Fishes: Genera, Species, References. (http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp). Electronic version accessed 03 Apr. 2017.

FILHOL H., 1885. – La Vie au Fond des Mers : les Explorations sous-marines et les Voyages du *Travailleur* et du *Talisman*. 303 p. Paris: G. Masson.

FROESE R. & PAULY D. (eds), 2017. – FishBase. World Wide Web electronic publication. www.fishbase.org. Accessed Feb. 2017.

GONZÁLEZ J.A., LOZANO I.J., CALDENTEY M.A., SANTANA J.I., GÓMEZ J.A. & CASTILLO R., 1988. – Resultados de la campaña de prospección pesquera Canarias 85. *Inf. Téc. Inst. Esp. Oceanogr.*, 57: 1-93.

GONZÁLEZ J.A., SANTANA J.I., GARCÍA-MEDEROS A.M., TUSET V.M., LOZANO I.J., JIMÉNEZ S. & BISCOITO M., 2008. – New data on the family Moridae (Gadiformes) from the Canary Islands (northeastern Atlantic Ocean), with first record of *Laemonema robustum*. *Cybium*, 32(2): 173-180.

GONZÁLEZ J.A., TARICHE O., SANTANA J.I., GARCÍA-MEDEROS A.M., TUSET V.M., JIMÉNEZ S. & BISCOITO M., 2010. – The family Moridae (Gadiformes) from the Cape Verde Islands (eastern-central Atlantic Ocean), with first record of *Physiculus cyanostrophus*. *Cybium,* 34(2): 217-221.

GÜNTHER A., 1862. – Catalogue of the Fishes in the British Museum. Catalogue of the Acanthopterygii, Pharyngognathi and Anacanthini in the collection of the British Museum. Vol. 4, 534 p. London: British Museum.

HUBBS C.L. & LAGLER K.F., 1958. – Fishes of the Great Lakes region. *Cranbrook Inst. Sci. Bull.*, 26: 1-213.

KAUP J., 1858. – Uebersicht der Familie Gadidae. *Arch. Naturgesch.,* 24(1): 85-93.

MENEZES G.M., TARICHE O., PINHO M.R., DUARTE P.N., FERNANDES A. & ABOIM M.A., 2004. – Annotated list of fishes caught by the R/V *Arquipélago* off the Cape Verde archipelago. *Arquipélago – Life Mar. Sci.*, 21A: 57-71.

PAULIN C.D., 1989a. – Moridae: Overview. *In*: Papers on the Systematics of Gadiform Fishes (Cohen D.M.,ed.), pp. 243-250. Los Angeles: Natural History Museum of Los Angeles County.

PAULIN C.D., 1989b. – Review of the morid genera *Gadella*, *Physiculus*, and *Salilota* (Teleostei: Gadiformes) with descriptions of seven new species. *N. Z. J. Zool.*, 16: 93-133.

REINER F., 2005. – Peixes do Arquipélago de Cabo Verde. 340 p. Mindelo, República de Cabo Verde: Instituto Nacional de Desenvolvimento das Pescas.

SABAJ PÉREZ M.H. (ed.), 2010. – Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an Online Reference. Version 6.5, published 16 Aug 2016). American Society of Ichthyologists and Herpetologists, Washington, DC. Available from: http://www.asih.org.

SANTOS R.S., PORTEIRO F.M. & BARREIROS J.P., 1997. – Marine fishes of the Azores. Annotated checklist and bibliography. A catalogue of the Azorean marine ichthyodiversity. *Arquipélago – Life Mar. Sci.* (Suppl.1): 1-244.

SHCHERBACHEV Y.N., 1993. – Preliminary review of the genus *Physiculus* (Moridae, Gadiformes) in the Indian Ocean and adjacent waters of the South Atlantic. *Trans. P. P. Shirshov Inst. Oceanol.*, 128: 147-178.

SHCHERBACHEV Y.N., KUKUEV E.I. & V.I. SHLIBANOV, 1985. – Composition of the benthic and demersal ichthyocenoses of the submarine mountains in the southern part of the north Atlantic range. *J. Ichthyol.*, 25(1): 110-125.

VAILLANT L., 1888. – Poissons. *In*: Expéditions scientifiques du "Travailleur" et du "Talisman" pendant les années 1880, 1881, 1883, 1883. 406 p. Paris: Masson.

VAN CHI-BONNARDEL R., 1973. – Grand Atlas du Continent Africain. 1^re^ édit. 335 p. Hollande: Jeune Afrique.